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## MEMORY OF A COMPLEX SKILLFUL ACT.

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During the winter of 1902 the writer investigated the learning process involved in keeping two balls going with one hand, one being caught and thrown while the other was in the air.<sup>1</sup> The present paper gives the result of a test of the ability of two of the subjects to perform the same feat after a lapse of over twenty-one months from the completion of the regular practice with the right hand, in the case of one of the subjects, and of more than twenty months in the other. The exact number of intervening days will be given below.

Subject A (the designation of the subjects is the same as was used in the former paper<sup>2</sup>) finished his regular right hand practice December 11th, 1902, and that of his left hand December 20th of the same year. After this there were five monthly tests of the effect of intermission of practice which ended May 21st, 1903. The memory tests with which the present paper deals were made on the 13th of September, 1904. Six hundred and forty-two days had therefore intervened since the right hand practice ceased and six hundred and thirty-three since the end of the work with the left hand. The monthly tests of the effect of intermission of practice were finished on May 21st, 1903, having a period between the close of these and the memory test with which this paper is concerned of four hundred and eighty-one days. Subject E finished his right hand practice January 6th, 1903, while his left hand practice and test of the effect of the intermission of practice ended, the one January 10th, 1903, and the other June 8th of the same year. Six hundred and sixteen days had therefore elapsed since the close of his right hand tests, six hundred and twelve days since the end of practice with his left hand and four hundred and sixty-three days since the monthly tests of the effect of the intermission of practice. During the intervening time neither subject had had any practice whatever. The memory tests made on the 13th of September, 1904, consisted, as in the original investigation, of ten trials. The tests were made in the same room and at the same time of day and under the same room conditions as be-

<sup>1</sup>Studies in the Psychology and Physiology of Learning, by Edgar James Swift, *Am. Jour. of Psychology*, Vol. XIV, 1903, p. 201.

<sup>2</sup>Loc. cit.

fore. Care was also taken to select similar balls. In order that the result of the memory tests may be compared with the right hand skill of the subjects at the close of the regular practice with that hand (A, Dec. 11th, 1902, and E, Jan. 6th, 1903), the scores of each for the two periods are placed side by side.

A		E	
At close of regular practice.	Memory test.	At close of regular practice.	Memory test.
1st, 52	1st, 52	1st, 34	1st, 89
2nd, 134	2nd, 56	2nd, 143	2nd, 168
3d, 90	3d, 67	3d, 98	3d, 165
4th, 44	4th, 163	4th, 122	4th, 156
5th, 166	5th, 165	5th, 149	5th, 144
6th, 186	6th, 215	6th, 164	6th, 318
7th, 72	7th, 21	7th, 186	7th, 193
8th, 216	8th, 183	8th, 140	8th, 133
9th, 49	9th, 92	9th, 147	9th, 127
10th, 42	10th, 173	10th, 85	10th, 26
1,051	1,187	1,268	1,519

The following scheme may, perhaps, aid us in our comparison of the results.

A.	E.
BELOW 50.	BELOW 50.
Regular practice, 3	Regular practice, 1
Memory test, 1	Memory test, 1
ABOVE 100.	ABOVE 100.
Regular practice, 4	Regular practice, 7
Memory test, 5	Memory test, 8
ABOVE 150.	ABOVE 150.
Regular practice, 3	Regular practice, 2
Memory test, 5	Memory test, 5
ABOVE 200.	ABOVE 200.
Regular practice, 1	Regular practice, 0
Memory test, 1	Memory test, 1

It will be seen from these figures that, in these respects, the memory tests were in no case inferior and in all but two instances were superior to the scores made at the close of the regular practice. If we consider the first score in the memory tests as representing the approximate skill of the subjects after the long lapse of time the succeeding scores will show the rapidity with which the feat was relearned, and introspection sustains this view since the throwing and catching seemed very strange during the first trial, but less novel during the second, and quite natural after that. Fatigue was the chief difficulty with which both subjects had to contend. Each one became

greatly fatigued with fifty throws, quite as fatigued as with three or four times that number in the regular practice, and after that the accuracy of the movements was greatly affected by this muscular condition. In a number of instances the failure to catch the ball and the "collisions" were clearly due to fatigue of the smaller muscles which in feats of this sort do the finer work. Each subject made several "recoveries" that were not excelled during any of the previous regular tests and the ease with which they threw and caught the balls, several times scarcely moving from their tracks, until handicapped by fatigue, showed that the old skill was still there. Since the subjects were obliged continually to work against accumulating fatigue the results of this test seem to show that the nervous system had forgotten little or nothing, and that whatever loss of skill the strangeness of the movements during the first and second trials indicated was chiefly muscular. In the ten trials the subjects gained a facility in handling the balls that they had not excelled at any period of the regular practice, if, indeed, it had been equaled, and this facility, together with the scores that they made, shows that they had acquired a skill which clearly exceeded that with which they ended the original learning process of four hundred and fifty trials for A and one hundred and forty for E. Bourdon<sup>1</sup> in testing the memory of certain mental processes, after an interruption of training for varying periods of even greater length, also found that there was no loss of skill, while in some instances there was an evident gain.

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<sup>1</sup>*L'Année Psychologique*, Vol. VIII, 1901, p. 327.